in the undercooled liquid by cavitation. A 2 c.c. sample of gallium contained in a sealed glass tube could be undercooled 25° (to 5° C) but nucleated in an ultrasound field with a few degrees undercooling. We believe that this is the first observation of such nucleation in a material other than water which expands on freezing.

In calculating the path taken during the collapse of a cavity, Hickling has considered only the temperature rise which results from reversible adiabatic compression. The collapse of a cavity is not reversible in the thermodynamic sense. The conditions should more closely approximate those in a shock front, as specified by the Rankine-Hugoniot[3] relationships. Using these equations we have calculated the irreversible part of the heating under such conditions[4]. This gives the temperature rise as indicated by the dotted line in Fig. 1. It is evident that the irreversible heating is sufficient so that the high pressure solid phase will not nucleate, because the liquid phase is stable over the entire path. The mechanism suggested by Hickling cannot, therefore, be operative in water. The nucleation must occur while the system is locally under tension, as has been suggested by Hunt and Jackson[4].

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Effect of Precipitation on Transmission through the Atmosphere at 10 Microns

The development of high power maser sources at 10·6 microns[1] has made possible an investigation of the characteristics of propagation through the atmosphere at this wavelength. Our investigations were conducted over the same 2·6 km path in Holmdel, New Jersey, which was used at shorter wavelengths by T. S. Chu and D. C. Hogg[2].

A continuous gas-flow 10·6μ oscillator, provided by T. J. Bridges[3] and operated to produce 0·5 W, was used as the source in our experiments. Observations were made continuously during most of the period from December 1965 to the end of May 1966. The 7 mm diameter output beam of the maser was directly transmitted during most of the work, although a 6 in. diameter Cassegrainian telescope was also used. The receiver was a thermopile placed at the focus of a 6 in. mirror. Mechanical chopping of the transmitted beam at 10 c/s and synchronous detection yielded a measuring range between 50 and 70 dB depending on the configuration used.

Fogs. During the past North American winter on ten occasions—each lasting several hours—we observed attenuation, due to fog, larger than our measuring range. On one such occasion we observed a fade of 50 dB which lasted a few minutes and which we were able to correlate with the movement into the beam of a patch of fog which intercepted less than half the 2·6 km path when the attenuation was maximum.

Snow. Because theoretical predictions of snow attenuation at different wavelengths have not so far been possible, it was of particular interest to observe the wavelength dependence of this effect. On six occasions during the past winter, appreciable snowfalls occurred and in each case there were periods, typically several hours long, during which the attenuation exceeded 50 dB. On one such occasion, simultaneous measurements were made by T. S. Chu at 0·63μ and 3·5μ. A comparison of the data indicates that the attenuation in decibels at 10μ was about 50 per cent greater than at the shorter wavelengths.

Rain. Most of the appreciable rainfalls during this period were accompanied by light fogs which produced the dominant attenuation and, therefore, obscured the effects resulting from the raindrops. On three occasions, however, rainfalls essentially free of fog were recorded. The attenuations observed were all between 8 and 10 dB/mile/in./h precipitation rate. (The rates measured ranged up to 2 in./h.) This result can be compared with the theoretical prediction of 11·5 (in the same units) by Chu[4]. Because this theory does not take into account the fact that some of the forward scattered signal is collected by the receiver, we consider the agreement between theory and experiment to be quite good.

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Variable Focal Length Lenses using Materials with Intensity Dependent Refractive Indices

Recent theory[1–3] and experiments[4–7] have demonstrated the existence of an intensity dependent non-linear component in the refractive index of some materials. This non-linearity in the refractive index has been observed to rotate an elliptically polarized optical maser beam[4,5] and to lead to self trapping[6,7]. This communication considers the two step nature of focusing which leads to the conclusion that a sample tank filled with one of these non-linear materials can be made to behave like a lens. It will be shown that it is possible for beam trapping to occur within the non-linear medium but for the beam to come to a focus outside the medium tank (see Fig. 1).

Consider, for example, a diffraction limited beam of the form

$$E^2 = \frac{8\pi^2 a^2 \eta_0}{c\lambda^2 R^2} P_t \left\{\frac{2J_1(ka\beta)}{ka\beta}\right\}^2 \tag{1}$$

where a is the radius of the aperture, λ is the free space wavelength of optical maser, η_0 the refractive index, c the velocity of light, R the distance from aperture, P_t the total beam power, $J_1(ka\beta)$ the Bessel function, and $\beta = \sin\theta$. If the non-linear refractive index is of the form

$$\eta = \eta_0 + \eta_2 E^2 \tag{2}$$

then the non-linear portion becomes

$$\eta_2 E^2 = \frac{8\pi^2 a^2 \eta_0 \eta_2}{c\lambda^2 R^2} P_t \left\{\frac{2J_1(ka\beta)}{ka\beta}\right\}^2 \tag{3}$$

From equations (2) and (3) it is obvious that the refractive index is not uniform across the beam owing to the power distribution in the beam. This means that the centre of the beam will be slowed more than the edges as shown in Fig. 1. The net result of this non-uniform phase delay across the beam is identical to what occurs in a lens as a result of the increased path length in the centre of the lens. If the same considerations are used here as in the case of thick lenses it is possible to determine an effective focal length for our non-linear system.

When the phase delay between the outer edge and the centre of the beam is computed for passage of the beam a distance ΔR in the tank, the effective difference in path